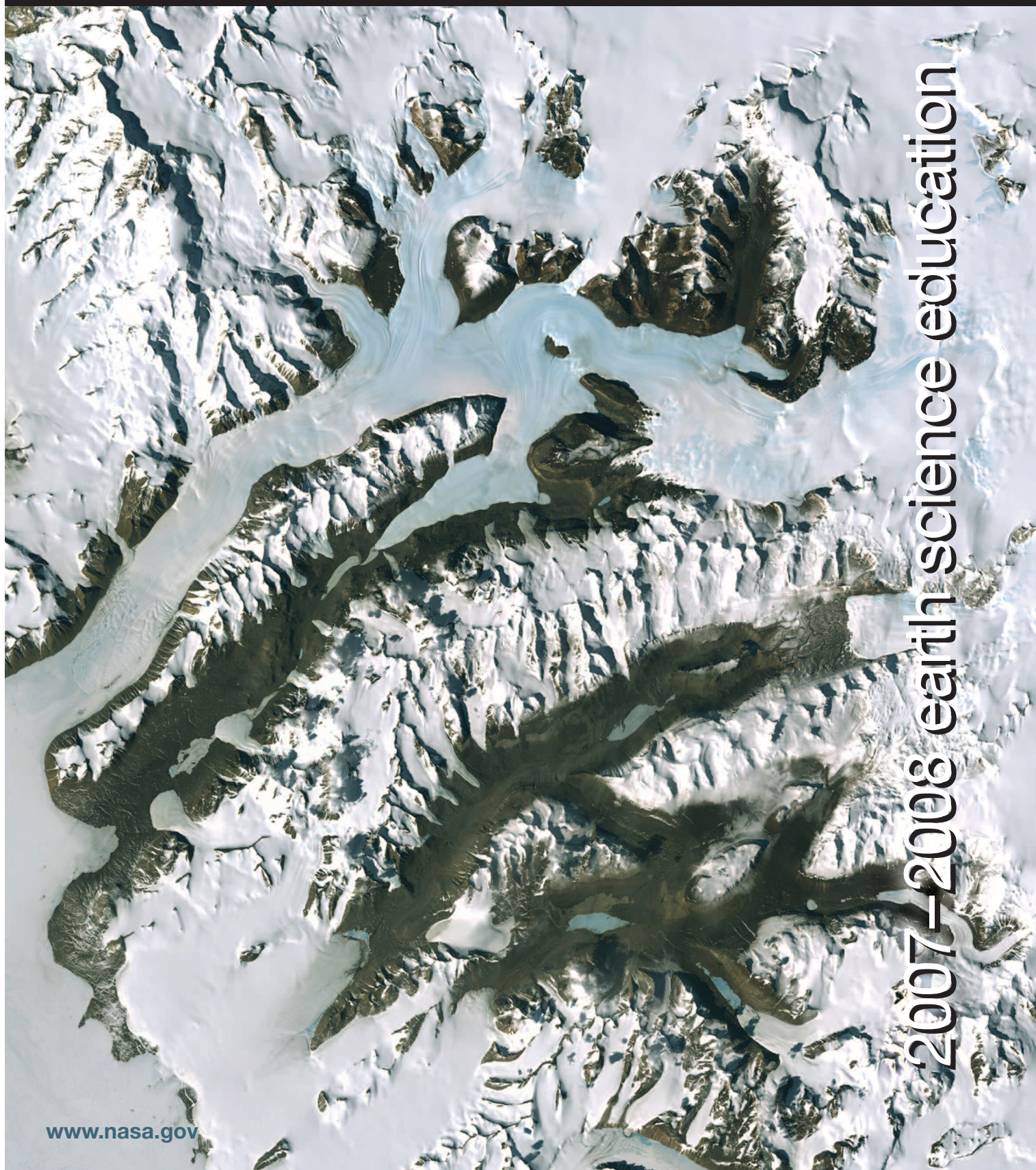
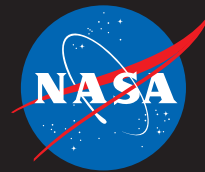


National Aeronautics and Space Administration



2007–2008 earth science education

[www.nasa.gov](http://www.nasa.gov)



## A Guide to NASA Science Mission Directorate Earth System Science Educational Programs and Resources

NASA offers a rich suite of programs and resources for educators, parents and students of all levels to actively explore and understand our Earth system. This guide presents a sampling for each level.

For more information on NASA's Science Mission Directorate, visit: [science.hq.nasa.gov](http://science.hq.nasa.gov).

To learn more about NASA Earth science education programs and resources, visit: [science.hq.nasa.gov/education](http://science.hq.nasa.gov/education).

### For the Latest NASA Earth Science and Education

Subscribe to the **Earth and Space Science Education E-News** by sending an email to: [esenewsletter@hq.nasa.gov](mailto:esenewsletter@hq.nasa.gov) or go to [science.hq.nasa.gov/education/edreports](http://science.hq.nasa.gov/education/edreports). This free monthly email newsletter includes upcoming educational programs, events, opportunities and resources.

Visit **NASA's Earth Observatory** • [earthobservatory.nasa.gov](http://earthobservatory.nasa.gov) • to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, track natural hazards around the world in near-real time, and access interactive experiments and classroom activities.

**Visible Earth** • [www.visibleearth.nasa.gov](http://www.visibleearth.nasa.gov) • is a comprehensive image gallery providing access to NASA Earth science images, animations and data visualizations.

**NASA Earth Observations (NEO)** • [neo.sci.gsfc.nasa.gov](http://neo.sci.gsfc.nasa.gov) • gives easy access to global-scale images allowing users to see and track ongoing climatic and environmental changes happening on Earth. With one or two clicks users can download high-resolution images, open them in GoogleEarth, or export them to easy tools for analysis.

Cover Image: High resolution LIMA data (Landsat Image Mosaic of Antarctica) centered over Ferrar Glacier. Produced by NASA and USGS, with support from NSF.

## Elementary & Secondary Education

**Earth Explorers** • [science.hq.nasa.gov/education/earth\\_explorers](http://science.hq.nasa.gov/education/earth_explorers) • is a series that introduces you to people of all ages and backgrounds who embody the spirit of discovery, and who use NASA science and technology to explore our home planet. Most articles are written in three different versions, one for each of three reading levels: grades K–4, grades 5–8, and grades 9–12 and up.

**EARTH+: Dynamic NASA Earth Science Exploration for Blind Learners** • [prime.jsc.nasa.gov/earthplus](http://prime.jsc.nasa.gov/earthplus) • is a tool to represent Earth science visual data, such as maps and other images, in a way that makes them accessible to students who are blind or visually impaired. Earth+ software makes NASA satellite images and data “viewable” to blind middle school students by providing advanced auditory image navigation tools so students “see” the images using sound cues about the features in the picture. Go to the Web site to download the free software and Earth science lessons on the study of dynamics and prediction of hurricanes and their impact on coastal communities. The project team includes experts from NASA Johnson Space Center; the University of Maryland, Baltimore Campus; Goddard Earth Science and Technology Center; and the University of Puerto Rico FILIUS Institute of Disabilities and Rehabilitation Research.

**GLOBE** • [www.globe.gov](http://www.globe.gov) • is a worldwide network of K–12 students who conduct grade-level appropriate research on the environment. Under the guidance of trained teachers, students make a core set of environmental observations and report and share their data with other students via the Internet. Scientists use GLOBE data in their research and provide feedback to students. Visualizations based on GLOBE student data can be created on the program's Web site. GLOBE observations and measurements include many variables relating to: atmosphere/climate, hydrology, land cover/phenology, and soils. The idea that Earth is a system of interconnected parts is at the root of the program. GLOBE is an interagency program funded by NASA and the National Science Foundation, supported by the U.S. Department of State, and implemented through a cooperative agreement between NASA, the University Corporation for Atmospheric Research, and Colorado State University in Fort Collins.

The **Measuring Vegetation Health** project • [mvh.sr.unh.edu](http://mvh.sr.unh.edu) • is developing hands-on activities for middle and high school students and the public to monitor vegetation health in their own environment, using inexpensive technologies. The activities are sequenced to focus on the local environment, first at very small scales, then with increasing spatial coverage. Measuring Vegetation Health will be integrated into both the Global Systems Science curriculum • [www.lawrencehallofscience.org/gss](http://www.lawrencehallofscience.org/gss) • created by the Lawrence Hall of Science at the University of California, Berkeley, and the University of New Hampshire's Forest Watch program • [www.forestwatch.sr.unh.edu](http://www.forestwatch.sr.unh.edu) • as well as remote-sensing curriculum developed at Indiana State University. The integrated series will be available as a stand-alone unit that can be incorporat-



**From top to bottom:**  
Photo 1, A View from Space;  
photo 2, Earth Explorers;  
photo 3, GLOBE; photo 4,  
S'COOL; photo 5, Signals of  
Spring

ed by teachers when needed, as a yearlong curriculum, or as activities for use by museums, science centers, arboreturns and botanical gardens.

**MY NASA DATA** • [mynasadata.larc.nasa.gov](http://mynasadata.larc.nasa.gov) • is an effort to make NASA Earth science data accessible to K–12 and citizen scientist communities. Datasets can be used with existing curriculum and enable students to practice science inquiry and math or technology skills using real measurements of Earth system variables and processes. MY NASA DATA microsets provide information on the atmosphere, ocean and land surface. New data types continue to be added to the collection. Data are available online along with lesson plans, teacher-friendly documentation, computer tools and an Earth science glossary. Science project starter ideas are also available.

**The New York City Research Initiative (NYCRI)** • [education.gsfc.nasa.gov/nycri](http://education.gsfc.nasa.gov/nycri) • is a NASA-sponsored program in which 20 teams of high school and college students and teachers are working with graduate students and scientists at 11 universities in New York, New Jersey and Connecticut, and at NASA Goddard Institute for Space Studies in Manhattan. In addition to performing research associated with NASA projects, participants attend conferences and weekly seminars, present oral reports, and visit nearby laboratories, museums and science centers. NYCRI also has an academic year component in which high school and college teachers incorporate NASA research into the classroom.

**OceanWorld** • [oceanworld.tamu.edu](http://oceanworld.tamu.edu) • is filled with oceans-related information and resources for middle–high school and college audiences. This Web site also includes lessons and activities, college-level courses and textbooks, sources of real-time data that can be used in the classroom, and links to numerous oceans references.

**Project 3D-VIEW (Virtual Interactive Environmental Worlds)** • [www.3dview.org](http://www.3dview.org) • engages grades 5–6 students in a comprehensive Earth system science program with teacher professional development. The program combines NASA mission data with 3D technologies in five units: lithosphere (land), hydrosphere (water), biosphere (life), atmosphere (air), and Earth systems. Simple Web interfaces enable students to explore, manipulate and navigate 3D stereo views and animations through hard copy, computer and immersive environments. The project is designed to increase student achievement in science (and includes literacy and mathematics components) by using 3D technologies to help students understand abstract concepts.

**In Signals of Spring** • [www.signalsofspring.net](http://www.signalsofspring.net) • middle and high school students investigate migration patterns of land and marine animals. Animal location data relayed from small satellite transmitters is overlaid onto maps of topography, vegeta-

tion, sea surface temperature and other NASA Earth data, prompting students to pose, research and analyze questions about the many factors affecting the migration and health of different species. Students use online journals, which are then read and commented on by Earth scientists and wildlife biologists. The program provides teacher training, which can be conducted onsite or by live, interactive Webcasts.

**The Space Place** • [spaceplace.nasa.gov](http://spaceplace.nasa.gov) • Web site for elementary-age kids features games, animations, projects, a cartoon talk show, and amazing facts related to Earth, space and technology. The Teachers Corner contains curriculum supplements originally published in the *Technology Teacher* magazine. Available in Spanish at • [spaceplace.nasa.gov/espanol](http://spaceplace.nasa.gov/espanol).

### Students' Cloud Observations On-Line (S'COOL)

• [scool.larc.nasa.gov](http://scool.larc.nasa.gov) • is a component of NASA's CERES (Clouds and the Earth's Radiant Energy System). The CERES instrument measures the amount of energy reflected and emitted by the Earth system. It focuses on understanding how clouds affect these energy transfers.

Participating students make basic weather observations and record the type and features of clouds in the sky at the time the satellite passes over their location. The data is then submitted to NASA (by Web, email, fax or mail) for entry into an online database. Students can access their results as well as those from other participating schools using the S'COOL Web site (which is available in seven languages). Satellite observations for matching times are also posted so that students can compare their observations to those of the satellite, and scientists can evaluate CERES' performance. Participants receive instructional materials and information necessary for reporting results.

## Higher Education

**GeoBrain** • [geobrain.laits.gmu.edu](http://geobrain.laits.gmu.edu) • mobilizes NASA Earth Observing System (EOS) data and information through Web service and knowledge management technologies for higher education teaching and research. The technologies, based on the geo-object and geo-tree concepts, are implemented through a Web-based information system called GeoBrain. The system makes petabytes of NASA EOS data and information easily accessible to distributed users. Users can dynamically and collaboratively develop interoperable, Web-executable geospatial service modules and geoprocessing models and run them online against any part of the petabytes of archived data and get back customized information products rather than raw data. George Mason University's Center for Spatial Information Science and Systems (CSISS), is conducting this innovative project with 12 university partners.





**From top to bottom:**  
Photo 1 & 2, Earth Explorers;  
photo 3, MS PHD's Ocean  
Science Program;  
photo 4, Remote Sensing  
Explorers at ECSU; photo 5,  
Eyes on Earth

**MS PHD'S®: Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science** • [www.msphds.usf.edu](http://www.msphds.usf.edu) • was established to reduce gaps in preparation, representation, and full participation of minorities within science communities. Programmatic outcomes include establishing and maintaining: (1) a supportive environment where undergraduate and graduate students develop strategies and professional skills necessary to pursue meaningful careers in Earth system science and engineering; (2) a community that facilitates and sustains mentor-mentee partnerships; (3) collaborative partnerships with professional organizations, federal agencies, industries, private foundations, and colleges and universities that are actively involved in facilitating the full participation of underrepresented minorities in Earth system science; and (4) a virtual community and listserv that facilitate student/scientist/educator/program officer communication and networking activities.

The **NASA Earth and Space Science Fellowship Program (NESSF)**, expanded in 2007 from the previous Earth System Science Fellowship Program, sponsors fellowships for students pursuing master of science or doctoral degrees in Earth and space science and related disciplines. The program's purpose is to ensure continued training of a highly qualified workforce in disciplines needed to achieve NASA's scientific goals. Research projects that are selected must be clearly relevant to NASA Science Mission Directorate research programs, missions or strategic objectives. Awards are made in the form of training grants to the respective universities with the advisor serving as the principal investigator. The annual program announcement is released in December/January and posted at • [nspires.nasaprs.com](http://nspires.nasaprs.com).

**NASA's Earth Observing System Data and Information System (EOSDIS)** • [nasadaacs.eos.nasa.gov](http://nasadaacs.eos.nasa.gov) • processes, manages and distributes Earth system science data products through 11 Distributed Active Archive Centers (DAACs) and related data centers. The centers archive and distribute data from past and current research satellites, field campaigns and other Earth science platforms. Each center serves one or more specific Earth science disciplines and provides data products and information, services and tools for diverse users.

**Remote Sensing Explorers** • [cerser.ecsu.edu/rse](http://cerser.ecsu.edu/rse) • is a partnership between Elizabeth City State University in North Carolina and the University of New Hampshire to deliver professional development workshops, related to classroom use of remote sensing and GIS, to faculty and students from minority-serving institutions. In addition to training workshops, faculty and students receive support for participation in a semi-annual distinguished lecture series.

**Satellite Observations in Science Education (SOSE)** • [www.ssec.wisc.edu/sose](http://www.ssec.wisc.edu/sose) • provides an Internet-based education environment for postsecondary students with interactive learning experiences in remote-sensing principles and exploratory data analysis. A major goal for this project is to offer a toolkit of *Reusable Content Objects* and *Reusable Evaluation Objects* that can be downloaded and easily edited by educators to build learning activities for any subject.

### Summer Fellowships for Undergraduate and Graduate Students

NASA offers summer research opportunities for college students, which typically last ten weeks, at NASA field centers where students are paired with a NASA scientist mentor. These include:

- Summer Institute on Atmospheric, Biospheric and Hydrospheric Sciences—[neptune.gsfc.nasa.gov/summerinstitute](http://neptune.gsfc.nasa.gov/summerinstitute)
- NASA Academies for undergraduates and graduate students—[academy.nasa.gov](http://academy.nasa.gov)
- Graduate Student Summer Program in Earth System Science—[gest.umbc.edu/student\\_opp/gssp.html](http://gest.umbc.edu/student_opp/gssp.html)

### Informal Science Education

**Earth & Sky** • [www.earthsky.org](http://www.earthsky.org) • is heard by millions of listeners each day on more than 1,000 commercial and public radio affiliates in the United States, on the Sirius and XM Satellite Radio networks, and internationally by Podcast and on dozens of independent stations and networks including American Forces Radio, World Radio Network and Voice of America. NASA sponsors a series of Earth science shows on Earth & Sky. Each 90-second show is based on interviews with NASA scientists and includes links to related Web sites and Project Learning Tree lesson plans.

**Earth Update** • [earth.rice.edu/connected/earthupdate.html](http://earth.rice.edu/connected/earthupdate.html) • is a graphical interface that allows access to Earth science information, animations, games and activities for K-12. It is organized by spheres: atmosphere, biosphere, geosphere, hydrosphere and cryosphere; the modules can be run alone, or as a linked system. Each sphere contains a library of hot topics, general topics and images that can be updated over the Internet. The Houston Museum of Natural Science developed Earth Update as an interactive museum display, but it is fun and educational for learners of all ages. An online version is available through the Web site; the CD version also includes three Earth science games and can be ordered online, with special pricing for K-12 teachers.

**Eyes on Earth** • [www.omsu.edu/visit/earth/eyesonearth](http://www.omsu.edu/visit/earth/eyesonearth) • is a 2,500 sq. ft. interactive, traveling science exhibition developed by the Oregon Museum of Science and Industry (OMSI) that focuses on NASA's Earth Observing System (EOS) and explores



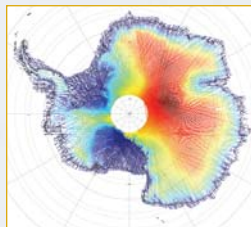
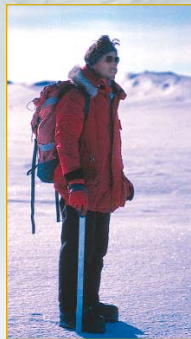
three major areas: Satellites, Orbits and Satellite Technology. Designed primarily for families and school groups (upper elementary+), Eyes on Earth brings these concepts down to Earth through a combination of fun, accessible interactives. The exhibit is available for leasing from OMSI through 2011.

**Immersive Earth** • [earth.rice.edu/connected/globetheater.html](http://earth.rice.edu/connected/globetheater.html) • produces movies that teach Earth science concepts using immersion in dome-shaped theatres. Through NASA funding, Rice University and the Houston Museum of Natural Science are partners in the five-year project that involves six museums, two universities and three private companies. Multiple projectors display the computer-generated images around all 360 degrees of a planetarium or large dome-shaped theatre. A single-projector system developed by the project allows for showings in portable inflatable domes, small enough to be brought out to schools and other venues. Over 75,000 have seen the shows in portables so far, including at rural and tribal sites. Daily or long-term rentals to schools, as well as system sales, are available.

**Science Bulletins** • [sciencebulletins.amnh.org](http://sciencebulletins.amnh.org) • from the American Museum of Natural History brings current science to the general public, informal learning centers and classrooms. The bulletins include three types of stories: features, data visualizations and bi-weekly news updates. A video and editorial crew follows scientists into the field to capture original video material and interview scientists about their work for the feature stories, which are presented as high-definition videos available to informal learning centers by subscription and as rich-media collections on the free Web site. Data visualizations in the Earth and Bio sections are based on satellite data sets from NASA and NOAA and presented in high-resolution for informal learning centers and in interactive formats on the Web. A standards-based educator's guide is provided for the Web site, and each new piece of media is accompanied by an educator's resource.

**A View from Space** • [www.oms.edu/store/traveling/unit.cfm?ID=22](http://www.oms.edu/store/traveling/unit.cfm?ID=22) • is a 700 sq. ft. bilingual (Spanish and English) traveling exhibit from OMSI that gives museum visitors a chance to see the world from a satellite's perspective. In this highly interactive, hands-on science exhibit, visitors are able to track a hurricane from space, send a satellite spinning into orbit around a model Earth, study astonishing images of our planet captured by NASA's Earth Observing System, and more. The exhibit is available for leasing through 2013 and is targeted at smaller and rural museum venues.

## 2007–2009 international polar year



**The International Polar Year (IPY)\*** is a coordinated effort by the international science and education communities to learn more about polar regions and their role in global processes, and to attract a new generation of scientists and engineers with the skills and imagination to tackle complex global issues.

Plunge into polar science and exploration at the Web sites below and visit the **NASA Polar Express** at • [ipy.nasa.gov](http://ipy.nasa.gov) • for the latest NASA IPY educational projects, resources, tools and images.

\*The IPY will last from March 2007–2009, to allow two field seasons of Arctic and Antarctic research.

**POLAR-PALOOZA** • [passporttoknowledge.com/polar-palooza](http://passporttoknowledge.com/polar-palooza) • is a national education and outreach tour to science centers and museums, designed to bring the poles to life through stories told by scientists who study the icy extremes of our planet on the ground and from space. Visit the Web site for 2007 host cities and dates, video clips from research expeditions, "Amazing but True" facts and misperceptions, classroom activities, blogs, links to webcams, and sound clips of penguins, seals, waves and breaking ice. Sponsored by NSF and NASA.

Take a **Tour of the Cryosphere** across the icy reaches of Antarctica, the drifting expanse of polar sea ice, the shrinking cap around the North Pole, and more • [www.nasa.gov/vision/earth/environment/cryosphere.html](http://www.nasa.gov/vision/earth/environment/cryosphere.html).

K–5 teachers can find lessons for **Exploring Ice in the Solar System** • [btc.montana.edu/MESSENGER/teachers/MEMS\\_CompPlanetology.php](http://btc.montana.edu/MESSENGER/teachers/MEMS_CompPlanetology.php).

Tune into the **International Polar Year at Earth & Sky** • [www.earthsky.org](http://www.earthsky.org) • to learn about NASA's unique contributions to Arctic and Antarctic research. The radio programs will also include interviews with scientists, segments highlighting Mars and lunar polar exploration (in English and Spanish), and links to related Project Learning Tree lesson plans.

Learners of all ages can have fun exploring polar science on Earth, as well as other planets, through **Windows to the Universe** • [www.windows.ucar.edu](http://www.windows.ucar.edu). Earth and space science teachers can keep up to date on IPY educational resources through the **National Earth Science Teachers Association** Web site • [www.nestanet.org](http://www.nestanet.org) • and learn to bring polar science into their classrooms through NCAR's **Climate Discovery online courses** • [ecourses.ncar.ucar.edu](http://ecourses.ncar.ucar.edu).

K–12 teachers are learning about polar regions and their role in the Earth system through in-depth undergraduate and graduate courses offered by colleges and universities participating in the NASA- and NSF-sponsored **Earth System Science Education Alliance** • [essea.strategies.org](http://essea.strategies.org) • conducted by the Institute for Global Environmental Strategies.

An online IPY educational package designed for libraries and after-school programs will be distributed through the Lunar Planetary Institute's successful **Explore!** program • [www.lpi.usra.edu/education/explore](http://www.lpi.usra.edu/education/explore). Webcasts and ongoing support will be provided for program facilitators on polar science content and IPY products and resources.






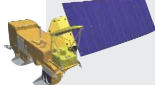





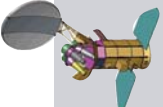





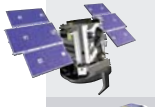

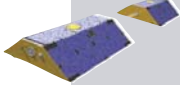








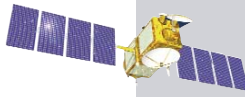
















The **Polar Literacy Networks** project (contact: [anita.m.sobus@jpl.nasa.gov](mailto:anita.m.sobus@jpl.nasa.gov)) brings together polar researchers, established educational and outreach networks, education/outreach experts, and partner organizations to develop consensus on Polar Literacy Key Concepts, provides network members with IPY professional development and educational resources, and evaluates public understanding of the importance of polar regions.

See the first high-resolution **Landsat Image Mosaic of Antarctica** featured at **Faces of Antarctica** • [lima.nasa.gov](http://lima.nasa.gov). Beginning in late 2007, users will be able to interact with Antarctic images and animations through guided, hands-on examples and data access and exploration tools. Faces of Antarctica will provide accessible imagery, visualizations, scientist interviews and narratives, as well as teacher-ready materials. This is a NASA, USGS and British Antarctic Survey partnership, with support from NSF.

## Education and Public Outreach

NASA's Earth science missions provide education and public outreach programs and resources for educators, students of all ages and the public. These include teacher workshops, student projects, and public programs and events as well as instructional

materials and resources, such as Web sites, CDs, posters, videos and brochures. Visit the individual mission Web sites identified below for specific information on their programs and resources, including mission results, satellite imagery and other data.

	Mission/Description/URL	Launch	Earth Measurements				
			 Air	 Land	 Water	 Ice	 Life
	<b>Aqua</b> Earth's water cycle, energy fluxes, aerosols, land vegetation cover, ocean biology, sea & land ice, & air/land/water temperatures • <a href="http://aqua.nasa.gov">aqua.nasa.gov</a>	2002					
	<b>Aquarius</b> Understanding the interaction between ocean circulation, the water cycle & climate by measuring ocean salinity • <a href="http://aquarius.nasa.gov">aquarius.nasa.gov</a>	2010					
	<b>Aura</b> Composition, chemistry & dynamic of Earth's atmosphere as well as the study of ozone, air quality & climate • <a href="http://aura.gsfc.nasa.gov">aura.gsfc.nasa.gov</a>	2004					
	<b>CALIPSO</b> <b>Cloud-Aerosol Lidar &amp; Infrared Pathfinder Satellite Observations</b> • Effects of aerosols & clouds on climate • <a href="http://www-calipso.larc.nasa.gov">www-calipso.larc.nasa.gov</a>	2006					
	<b>CloudSat</b> Structure, composition & effects of clouds on a global basis • <a href="http://cloudsat.atmos.colostate.edu">cloudsat.atmos.colostate.edu</a>	2006					
	<b>GRACE</b> <b>Gravity Recovery and Climate Experiment</b> • Map Earth's gravity fields • <a href="http://www.csr.utexas.edu/grace">www.csr.utexas.edu/grace</a>	2002					
	<b>ICESat</b> <b>Ice, Cloud &amp; land Elevation Satellite</b> • Ice sheet mass balance, cloud & aerosol heights (esp. over polar areas), land topography, & vegetation (polar & global) • <a href="http://icesat.gsfc.nasa.gov">icesat.gsfc.nasa.gov</a>	2003					
	<b>Jason-1</b> Monitor ocean surface topography & global ocean circulation to improve global climate predictions, & monitor events such as El Niño conditions & ocean eddies • <a href="http://sealevel.jpl.nasa.gov">sealevel.jpl.nasa.gov</a>	2001					
	<b>Landsat Data Continuity Mission</b> Continuing over 35 years of Landsat's unique landscape-scale data & images, mapping human & natural-caused changes on land & coasts (with USGS) • <a href="http://ldcm.gsfc.nasa.gov">ldcm.gsfc.nasa.gov</a>	2011					
	<b>Orbiting Carbon Observatory (OCO)</b> First space-based measurements of atmospheric CO <sub>2</sub> to characterize sources & links • <a href="http://oco.jpl.nasa.gov">oco.jpl.nasa.gov</a>	2008					
	<b>Terra</b> Global measurements of atmosphere, land & oceans mainly to improve understanding of Earth's energy & carbon budgets • <a href="http://terra.nasa.gov">terra.nasa.gov</a>	1999					
	<b>TRMM</b> <b>Tropical Rainfall Measuring Mission</b> • Monitor & study tropical rainfall • <a href="http://trmm.gsfc.nasa.gov">trmm.gsfc.nasa.gov</a>	1997					

NOTE: This table does not represent all of NASA's past and future Earth science missions. Please visit • [www.asd.ssc.nasa.gov/m2m](http://www.asd.ssc.nasa.gov/m2m) • to learn about all of NASA's Earth science missions.